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FINAL REPORT

VELA UNIFORM PROGRAM

PROJECT DRIBBLE

SALMON EVENT

TATUM SALT DOME, MISSISSIPPI

22 OCTOBER 1964

part of an experiment in seismic decoupling at the nuclear level

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Final Report of Off-Site Surveillance

MELVIN W. CARTER / O. R. PLACAK
U. S. PUBLIC HEALTH SERVICE

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FINAL REPORT OF

OFF-SITE SURVEILLANCE FOR

THE SALMON EVENT OF

PROJECT DRIBBLE

October 22, 1964

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FOREWORD

The information and data presented in this report were compiled to summarize the activities conducted by the Off-Site Radiological Safety Organization relative to the Salmon Event, Project Dribble. The activities prior to the shot, during the active test period, and subsequent to the shot are discussed.

Acknowledgements are extended to the personnel of the Southwestern Radiological Health Laboratory, Las Vegas, Nevada; Southeastern Radiological Health Laboratory, Montgomery, Alabama; and Northeastern Radiological Health Laboratory, Winchester, Massachusetts; and reserve PHS officers (temporary duty) for making the Off-Site Radiological Safety activities successful.

Acknowledgements are also extended to state and local health department officials in Mississippi and Louisiana for their assistance in off-site activities.

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CHAPTER 1

INTRODUCTION

The Salmon Event was the first nuclear detonation involved in a study, identified as Project Dribble, sponsored by the Department of Defense's Advanced Research Project Agency. Project Dribble involves the recording and identification of seismic signals from a planned series of three underground detonations. These studies are part of a seismic research program called Vela Uniform which is designed to improve the United States' capability to detect, identify, and locate underground nuclear detonations.

The Salmon Shot was fired at 1000 hours CST on October 22, 1964, approximately 19 air miles southwest of Hattiesburg, Mississippi, in a salt formation known as the Tatum Salt Dome, Lamar County, Mississippi. The device was buried 2,720 feet below the surface of the earth and was designed for a 5 kt yield. At shot time, the mean layer winds from 0 to 5,000 feet were from 260° at 6 knots. The surface winds were from 280° at 6 knots.

In accordance with a memorandum of understanding between the two agencies, the program of off-site radiological surveillance for the Salmon Event of Project Dribble was conducted by the

U. S. Public Health Service for the U. S. Atomic Energy Commission. The functions of the Public Health Service for the Salmon Event were as follows:

(1) Determination by mobile and fixed monitoring stations and aerial surveys of the extent of airborne, surface and subsurface contamination off-site resulting from the operation.

(2) Maintenance of a comprehensive record of radioactivity associated with the operation, including fluctuations in background data.

(3) Insurance of continuing public health protection, including sampling of various media such as water, milk, soil, vegetation and animal tissue, as required.

(4) Preparations for effecting emergency measures in the event of development of an unacceptable situation.

(5) Dissemination of necessary public information in surrounding communities for maintenance of public confidence in the safe conduct of the operation.

(6) Investigation of incidents that might be attributed to the operation.

(7) Distribution and collection of film badges.

(8) Provision of mobile monitoring teams in selected populated places surrounding the operation site.

(9) Location of air-sampling equipment and continuous recorders, and securance of local personnel for operation of the sampling stations.

(10) Evacuation of certain portions of the off-site area.*

(11) Maintenance of off-site radiological surveillance during post-shot activities.

Activities associated with (10) above included:

(a) evacuation of certain portions of the off-site area (0 to 2.6 miles from Surface Zero) relative to structural damage and radiological safety, (b) evacuation of certain downwind sectors (2.6 to 5 miles), concerned with radiological safety, and (c) medical support relative to evacuating individuals living in the off-site area who were not physically able to evacuate themselves.

One of the most important objectives of the Off-Site Radiological Safety Organization was to develop a plan for meeting any possible emergency associated with the contamination of the milk in the off-site area. Due to the large number of dairy farms within a 50-mile radius of the test site, Project Dribble presented a much greater potential problem in the event of release of radioactivity than other tests of this nature. An extensive program for obtaining information and data relative to the dairy industry was initiated.

The public relations aspect of this project was much more challenging than in past tests since a large number of people

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*The off-site area is defined as that area within a 50-mile radius of Surface Zero, or as far beyond this area as Public Health Service activities are deemed necessary.

live in the immediate off-site area and this was the first Atomic Energy Commission operation of this nature in the Mississippi area.

Due to the number of individual activities being conducted in the off-site area, problems could have been encountered relative to annoying the populace. (Excessive visitation of the homes could have caused the people to tire of the project.) It was also apparent that individuals working in the area had to be extremely careful as to information they related to the off-site populace. Coordination of information was necessary to insure presentation of factual information and to minimize rumors and ambiguous reports. Also a large number of local people living within the areas to be evacuated were employed at the test site.

Maintaining good public relations was considered one of the most important objectives of Public Health Service activities.

CHAPTER 2

PROCEDURE

2.1 PRELIMINARY PROCEDURE

Prior to the Salmon Event, particular emphasis was placed on the need for information relative to (1) possible evacuation of the close-in areas around the test site, (2) distribution of dairies and family-type milk cows, (3) the public attitude toward Project Dribble, and (4) background radioactivity in the environment.

The following is a description of the pre-Salmon Event activities conducted by the Public Health Service.

2.1.1 Evacuation. From April through August 1963, a house-to-house population survey was made in the total area within a 4.5-mile radius of Surface Zero. The survey was extended to a 10-mile radius in the northern hemisphere (270^{o} - 360^{o} - 90^{o}) and in the 45^{o} sector from 225^{o} to 270^{o}. This survey was conducted to determine the number and location of people living in these areas for purposes of planning for evacuation. At that time, it was determined that 980 people lived within a 4.5-mile radius of Surface Zero and 1,993 people lived in the area from 4.5 to 10-miles in the north and the 45^{o} sector in the southwest. Each house within these areas was assigned a code number and this code number was referenced to a map.

At the time of the population survey, information was also obtained on the domestic animals at each residence, including chickens, cattle, swine, goats, etc. As the survey progressed, Public Health Service officers familiarized themselves with the roads in the off-site area and became acquainted with the people and their attitudes.

During the initial contacts, many questions were asked of the Public Health Service officers relative to possible damage to water wells, physical damage and damage to animals. The people were also interested in the possibility of the Atomic Energy Commission needing more land than they had leased at that time. During the numerous contacts, the attitudes of the people toward the project varied noticeably from one individual to another, but were in general considered to be very good.

Upon completion of the population survey, a report was compiled containing the names of the residents referenced to code numbers on maps, including the number of people at each occupied house, and also referencing these houses in terms of the distance from Surface Zero.[1]

In anticipation of possible structural damage from the Salmon Event, a structural survey was made in April 1963, of all the structures within a 4.5-mile radius of Surface Zero. This survey was made by Holmes & Narver, Inc., under contract with the Atomic Energy Commission. Public Health Service officers participated in this project by contacting the residents prior to the

survey and obtaining verbal permission for the survey to be conducted.

Beginning in July 1964, Public Health Service reserve officers were activated to participate in the Salmon Event activities. At this time, it was determined desirable to update the information concerning the population in the off-site area. The off-site area, out to five miles, was divided into twelve 30^{o} sectors and reserve officers were assigned to each one of the sectors. The reserve officers surveyed the assigned sectors to locate all occupied houses and obtain the following information: (1) the name of the head of the household, (2) the names and ages of all individuals living in the house, (3) whether individuals would evacuate if requested to do so, and (4) in the event of evacuation, (a) any illness that might require medical attention, (b) transportation requirements, (c) the time the family could evacuate relative to a 1000-hour shot time, and (d) the destination, address and telephone number. This information was compiled into data sheets for each sector.

The general plan was to evacuate (1) all people living within a 1.6-mile radius, (2) those people in the area from 1.6 to 2.6 miles in the northern hemisphere, and (3) those people in selected northern sectors from 2.6 to 5.0 miles, depending on the wind direction. Those people living in the southern area from 1.6 to 2.6 miles were to assemble out of doors at seven assembly points. A PHS officer was to be stationed at each assembly point. Evacuees

were to be paid a reasonable amount for expenses incurred while they were away from their homes.

On the evening of D-1 day, if the 1500-hour weather briefing indicated favorable conditions for D-day, the PHS officers were to contact the potential evacuees and assemblees and alert them to the possibility of their being asked to evacuate their homes on the following day. If the 0300-hour weather briefing on D-day was favorable, the PHS officers were to contact the people living in the evacuation areas and ask them to leave their homes. Roadblocks were to be established by the AEC in coordination with the Mississippi State Highway Patrol and each family was to clear through a roadblock when leaving the area. After the shot, when re-entry was allowed, the people were to again clear through the roadblocks when entering the areas.

2.1.2 Medical Activities. Based upon the information obtained in the population survey, the Project Medical Officer visited all medical cases within the 5-mile radius. Permission was obtained from the family to discuss each case with a local physician in order to plan for these cases at shot time. In coordination with local physicians, the medical officer evaluated the cases in terms of the feasibility of evacuating them to hospitals, relatives' homes, or other places, prior to the shot.

The Project Medical Officer also visited county hospitals in the area and explained his program. He contacted local ambulance services and arranged support for the Public Health Service in terms

of evacuating certain medical cases in the area prior to the shot and returning them to their homes.

2.1.3 Dairy Cattle, Milk Processing Plants, and Feeding and Farming Practices Associated with the Dairy Industry. To evaluate any potential hazard with regard to milk and plan for remedial action if necessary, a program to obtain information on dairying in the off-site area was initiated. From April through August 1963, a milk shed survey was conducted. Information was obtained in regard to (1) location of dairy farms within a 50-mile radius and the number of cows at each farm, (2) name of the driver who collected the milk, and (3) processing plant that processed the milk. The survey revealed that a total of 1,584 dairy farms were located within a 50-mile radius of Surface Zero.

These dairies were referenced in code form on individual county maps and a report was issued.[2]

In May 1964, a survey was made of all processing plants receiving milk from counties within a 50-mile radius, and information was gathered relative to the (1) volumes of milk processed, (2) counties from which the milk came and the volumes contributed, (3) products produced from the milk, and (4) distribution points for the finished products and the volumes of milk represented in the finished products. This information was compiled in a report.[3]

Concurrently, a survey was made concerning feeding practices and farming procedures that were being used on the dairy farms.

This included the acquisition of such information as the (1) number of cows milked, (2) volumes of milk produced, (3) amount of grazing land available and the times of year that the land could be grazed, (4) amount of dairy feed available and the times of availability, and (5) capacities of barns. This information was used to plan for the amounts of feed that might be needed if an area were contaminated. A total of 100 dairy farms were visited during this survey.

In August 1964, a house-to-house survey was conducted to obtain information on family-type milk cows located within a 5-mile radius of Surface Zero. This information was used in developing a milk sampling program in the immediate off-site area.

During the time prior to the shot, contact was maintained with the state and local health departments in Mississippi and Louisiana to coordinate public health activities on a local level. The assistance of the states was most helpful in gathering the information relative to the dairy industry, and in particular, the assistance of the milk sanitarians in the local health units was of great benefit.

A Project Veterinary Officer was also on duty to discuss with the local populace any veterinary problems in the off-site area.

2.1.4 Environmental Sampling. An environmental sampling program to determine existing levels of radioactivity and normal variations in these levels was initiated in May 1963. This

program included the following media: (1) air, (2) water, (3) milk, and (4) vegetation. These samples were analyzed at the Southeastern Radiological Health Laboratory, Montgomery, Alabama, and reports were issued on a monthly basis.[4] These reports included sample analyses results for the environmental sampling stations that were established for background purposes and with the exception of a few cases, did not include data for the special samples that were collected relative to the Salmon Event.

The procedures used for collecting these environmental samples follow:

(1) Air Sampling - In May 1963, four air sampling stations were established (samples collected five days per week). On September 26, 1964, 23 additional air sampling stations were established (running seven days per week) giving representative coverage for an area bounded by a 50-mile radius. The stations were placed in the more populated areas surrounding the test site and were operated through October 28, 1965. After this date, the air sampling program reverted back to the four routine stations. Samples were collected with the General Metal Works, Model 2000 Hi-Volume Air Sampler, using a Gelman, Type E, 8" x 10" glass fiber filter. Refer to Figure 2.1 for permanent air sampling station locations.

(2) Water Sampling - Initially, 47 water sampling stations (samples collected monthly) were established. The samples represented private and public water supplies as well as surface streams. Just prior to the shot, 10 additional water sampling stations were established in the off-site area. These additional

stations were established outside a 5-mile radius of Ground Zero. Although background samples were collected from these stations, no post-shot samples were analyzed since it was determined that the routine sampling stations provided sufficient coverage. The majority of the samples were collected within the 5-mile radius. Refer to Figure 2.2 for water sampling station locations. As indicated on this figure, five of the water sampling stations are not shown. Also, the 10 additional stations established just prior to the shot are not shown since they were not activated.

(3) Milk Sampling - Twelve milk sampling stations (milk routes), collecting samples twice a month, were set up in May 1963. These stations represented 219 dairies and gave representative coverage within the off-site area. The milk samples were collected from bulk tank milk trucks at the various stations, and hence, each sample represented a number of dairy farms from which the bulk tank truck collected milk. See Figure 2.3 for the number of dairies that these samples represented in each county.

In addition to the bulk tank truck samples, 21 milk sampling stations were set up within the 5-mile radius for close-in coverage. These samples were collected from family-type milk cows (non-commercial) three times prior to shot day for background purposes. Refer to Figure 2.4 for these station locations.

(4) Vegetation Sampling - Four vegetation sampling stations were established initially. These samples were collected monthly.

Prior to the shot, 17 additional vegetation sampling stations were established within the 5-mile radius. See Figure 2.5 for locations of vegetation sampling stations.

2.2 PROCEDURES, SALMON EVENT

2.2.1 Evacuation. Based upon a forecast of favorable wind conditions, people were alerted and evacuated from certain areas on three occasions. After each of the first two evacuations, the shot was postponed. After the third evacuation, the device was detonated, and operations proceeded smoothly. The following are brief descriptions of each evacuation operation.

A. On the evening of October 7, 1964, the people in the 0 to 2.6-mile area and those in the predicted downwind sector out to 5.0 miles were alerted as to the possibility of the shot on October 8. At 0530 hours on October 8, PHS officers began evacuating the selected areas in preparation for a shot time of 1000 hours. A total of 326 people were evacuated and 127 were assembled at the 7 assembly points. The event was postponed due to unfavorable wind conditions and the people were allowed to re-enter the areas.

B. On October 11, it was forecasted that the meteorological conditions would be favorable for the shot on the following day. The PHS officers alerted the people in selected sectors, and on October 12 evacuated 390 persons. The entire area from 0 to 2.6 miles was cleared of all people, rather than having those people living in the southern half of the area meet at assembly points. In addition, those people in the predicted downwind sectors were

evacuated out to 5.0 miles. During this and the final evacuation, PHS officers escorted each family group to a roadblock to verify their leaving the area. Again the event was postponed due to unsuitable wind conditions and the evacuees were allowed to return home.

C. On October 21, favorable conditions were predicted for the following day. The people in the 0 to 2.6-mile area were alerted, as well as those in four 30^{o} sectors from 0^{o} to 120^{o} out to 5.0 miles. On October 22, D-day, only three of these sectors were selected for evacuation, covering the area from 0^{o} to 90^{o} out to 5.0 miles. Of course, the 0 to 2.6-mile area was also cleared of people. Evacuation was initiated at 0530 hours by PHS officers. The area from 0 to 1.6 miles was confirmed evacuated at 0815 hours, and the entire area was clear at 0830 hours. Due to wind changes, it was then determined that the additional 30^{o} sector (90^{o} to 120^{o}) should be cleared. PHS officers evacuated the people in this sector and confirmed that it was clear at 0910 hours. A total of 451 people representing 105 families were evacuated from their homes on D-day (see Figure 2.6).

For each evacuation operation, the Project Medical Officer arranged to move those individuals who required special care. Certain cases were housed temporarily in local hospitals and the expenses of moving by ambulance, hospitalization, special nurses, and other medical care were borne by the AEC. Nine individual

medical cases were dealt with by the Project Medical Officer during the operation.

For each evacuation, the PHS officers assisted the evacuees in filling out the forms necessary for reimbursement. The people were paid promptly by AEC representatives after each evacuation operation.

2.2.2 Re-Entry. After the shot, when re-entry was permitted, PHS officers escorted those evacuees who lived in the 0 to 2.6-mile area back to their homes, coordinating each family's re-entry with the Control Point. Upon escorting a resident to his home, a cursory inspection of the dwelling was performed by the PHS officer to insure that the dwelling was safe to enter and occupy. Noticeable damage was reported to the Control Point.

As a precautionary measure in the event of structural damage, the people in the 2.6-mile area had been advised to turn off the main gas valves in their bottled gas systems when leaving their homes. After the shot, PHS officers accompanied gas company specialists as they inspected the gas systems and turned on the gas at each house in the 2.6-mile area.

2.2.3 Information Booths. On D-1, D-day, and D+1 for the postponed operations as well as the actual shot, PHS officers manned information booths at Baxterville, Mississippi, and Purvis, Mississippi, to provide information to the off-site people on the status of the operation. On D-day, these booths were very helpful in coordinating claims relative to structural damage.

2.2.4 Ground Monitoring. A total of 28 ground monitoring teams were employed in the field during the Salmon Event. The following instruments were used for field monitoring: Eberline Model E-500B; Precision Scintillator Model 111; and Radector Model 500.

Monitoring missions were carried on in the field from H-60 minutes to H+95 minutes, at which time it was determined that no detectable release of activity had occurred.

Figure 2.7 indicates the off-site roads that were monitored.

2.2.5 Aerial Monitoring. A two-man Public Health Service aerial monitoring team, flying in the USAF U3-A 75885 piloted by Captain Gille, made numerous passes over Surface Zero at treetop height. The following instruments were used: Eberline Model E-500B; Precision Scintillator Model 111; and an EG&G ARMS unit. This operation terminated at H+49 minutes. See Table 2.1 for aerial monitoring data.

A Public Health Service aircraft (C-45) was standing by at the Hattiesburg Airport for use in sampling airborne radioactivity. A four-man team manned the aircraft. This aircraft was equipped to sample gaseous as well as particulate radioactive material. Since no activity release was detected, the C-45 remained at the Hattiesburg Airport.

2.2.6 Film Badge Program. Six hundred and ninety-three badges were distributed by off-site personnel, beginning

September 12. Two hundred and eighty-eight badges were distributed within the 5-mile radius. Thirty-nine of these badges within the 5-mile radius were distributed across the predicted downwind pattern and 60 badges were issued to the Mississippi State Highway Patrol. The remainder of the badges within the 5-mile radius were issued to off-site people.

Two hundred and five badges were distributed within the 50-mile radius at 41 film badge stations - 5 badges per station.

Due to a shortage of film badges on-site and at the request of the Technical Director, two hundred badges were issued to Lawrence Radiation Laboratory representatives for their use. These badges were positioned across the predicted downwind pattern on-site and were not issued to personnel.

Personal film badges were distributed, one per household, out to 5.0 miles in the northern hemisphere and out to 2.6 miles in the south. One person per household was badged at approximately 30 per cent of the residences in the southern hemisphere from 2.6 to 5 miles. Figure 2.8 indicates the personal film badge distribution. The locations of film badge stations are shown in Figure 2.9. All dosimetry results for station and personal film badges indicated no detectable exposure.

2.2.7 Background Recorders. Seven background recorders (Eberline Radiation Monitor, Model RM-11) were stationed in the off-site area. These recorders began operation at 0800 hours on

D-day and operated through H+7 days. No activity above background was indicated on the charts. For recorder locations, refer to Figure 2.10.

2.2.8 Environmental Sampling. Environmental samples representing air, milk, water, and vegetation were collected prior to and after the shot. The following outline indicates the environmental sampling coverage that was in operation at shot time:

Type of Sample	No. of Stations	Refer to Figure
Air	27	2.2
Milk	21 (1-2 cows), 12 milk routes (composite samples)	2.5 2.4
Water	47	2.3
Vegetation	21	2.6

In addition to these stations, special samples of air, vegetation, and water were collected immediately after the shot and analyzed at the PHS laboratory in Hattiesburg. All of the special samples indicated no activity above background. For results of environmental sample analyses prior to and immediately following the shot, see Chapter 4 (4.1 - 4.2.4). Also included in 4.2 are radiation monitoring and evacuation results relative to the Salmon Event.

CHAPTER 3

POST-SHOT ACTIVITIES

On February 8, 1965, Public Health Service officers were activated to participate in the post-shot activities (cavity penetration and bleed down) for the Salmon Event of Project Dribble. A total of 16 men participated during the period from February 8, 1965, to April 2, 1965. These personnel were comprised of PHS reserve officers called to active duty and permanent personnel from the Southeastern Radiological Health Laboratory, Montgomery, Alabama.

To facilitate activities in the field, a trailer was provided for the Public Health Service at the Technical Director's Manned Station. The Off-Site Radiological Safety Program was coordinated with AEC Operational Safety and AEC Project Operations who occupied space in this same trailer.

The purpose for bringing in additional Public Health Service personnel related to the post-shot activities was to provide off-site radiological safety coverage during the drill-back procedure on post-shot #1 and to afford coverage during the bleed down of the cavity. Although predictions indicated that there would be no radiological problem off-site, these additional men were used

to keep a continuous record of background fluctuations and/or releases associated with the post-shot activities as well as provide the capability for coverage in the off-site area in the event of an unforeseen emergency. Since the post-shot activities varied from day to day and were governed primarily by what was learned as the drill-back progressed, the Public Health Service off-site operation went on a 24-hour surveillance prior to cavity penetration. The activities associated with off-site coverage for the post-shot drilling and cavity study are briefly described below.

Prior to cavity penetration, the environmental sampling program was increased beginning February 15, 1965. For the purpose of coverage during drill-back and cavity studies, 11 additional air sampling stations, 21 additional milk sampling stations, 17 additional vegetation stations, and 2 RM-11 radiation background recorders were put into operation within a 5-mile radius of Ground Zero. Prior to February 15, 4 air, 47 water, and 4 vegetation sampling stations, as well as 12 composite milk sampling routes, were in operation for routine coverage. This sampling coverage extended out to a 50-mile radius from Ground Zero. This routine program was re-established in November 1964 since no release of radioactivity was indicated as a result of the Salmon Event. Environmental sampling coverage is shown in Figure 3.1. As can be noted in this figure, the composite milk sampling stations and the water sampling stations were the same as they were for the Salmon Event.

The 15 air sampling stations that were in operation utilized a Gelman, Type E, glass fiber filter and an MSA charcoal cartridge. The air samples were collected by means of the General Metal Works Hi-Volume air sampler. The cartridges from these stations were analyzed for gamma activity at the PHS laboratory in Hattiesburg and the pre-filters were analyzed for beta and gamma activity either in Hattiesburg or at the Southeastern Radiological Health Laboratory, Montgomery, Alabama, according to the activities on-site. On days that a small release from the drilling area was indicated, the filters were gamma scanned and counted for gross beta in Hattiesburg. During the periods of time that no release was indicated, the filters were submitted to Montgomery for analyses.

At periodic times during the post-shot activities which reached a peak on March 6, 1956 (began official bleed down of cavity), special air samples were collected in the off-site area by means of portable generators and analyzed in Hattiesburg.

Public Health Service officers began operating on a 24-hour basis on February 22, as drilling neared the cavity. These officers made routine radiation monitoring runs as well as special monitoring runs in the off-site area when deemed necessary and collected milk, water, vegetation, and air samples as required.

On the morning of March 4, 1965, the cavity was penetrated at the depth of 2,660-61 feet. The temperature of the cavity was

found to be approximately 400°F and surveys were run that indicated that the bottom of the cavity was approximately 2,747 feet below surface.

Although the bleed down plant had operated at periodic times during drill-back, it was put into full-scale operation on March 6, 1965, and was operated most of the day in connection with the cavity flushing procedure. The plant remained in operation at periodic times afterward. During the periods of time the bleed down plant was in operation, PHS ground monitoring teams were divided into two groups; one group monitored in downwind areas and the other group monitored 360° around the site. The PHS monitors utilized the Scintillator Model 111 and the Eberline E-500B instruments. The monitors in the downwind areas operated mobile air sampling units and collected special vegetation samples during bleed down activities. All radiation ground monitoring results during this period were negative.

Special milk samples were also collected from the majority of the milk stations shown in Figure 3.1. For post-shot sampling results, see 4.3 (RESULTS, POST-SHOT SAMPLING).

In addition to PHS ground monitors, a special EG&G aerial monitoring team was in the area at periodic times during post-shot activities. Public Health Service off-site activities were coordinated with this aerial monitoring team and on-site radiological safety activities. Downwind patterns were established by the U. S. Weather Bureau at frequent weather briefings.

CHAPTER 4

RESULTS

4.1 RESULTS, ROUTINE SAMPLING+

4.1.1 Vegetation. From May 1963 through March 1965, the following radionuclides were detected in vegetation at the four routine vegetation sampling stations (Figure 2.5 - A-27, 12, 52, 03): Ce-144, Ru-103, 106, Cs-137, Zr-Nb-95, K-40 and Mn-54.

Analyses of these samples showed that during this period the maximum concentrations of Ce-144, Ru-103, 106, Cs-137, and Zr-Nb-95 occurred in March of 1964. The maximum concentrations of K-40 were detected in November 1963, whereas Mn-54 reached its peak in November 1964.

The analyses indicated that Ce-144 was not detected beginning in May 1963. It began appearing in January 1964, reached its peak in March, gradually decreased to zero in September and October, and began to rise again in November. The months that the other radionuclides were detected are as follows: Ru-103, 106 - each month; Cs-137 - September 1963 - March 1965; Zr-Nb-95 - each month, with the exception of November 1964; K-40 - each month, with the exception of January 1964; and Mn-54 - November 1964 and March 1965.

+ This information summarized from "Project Dribble, Off-Site Radiological Surveillance," monthly reports since May 1963.

During the routine sampling from May 1963 through March 1965, no I-131 above minimum detectable levels was noted in any of the routine vegetation samples.

4.1.2 Milk. Figure 4.1 indicates the background fluctuations for Cs-137 and Sr-90 (at time samples were counted) in composite-type milk samples that were collected from May 1963 through March 1965. The values are average concentrations per sample that were detected in the composite samples during each month. The number of samples submitted per month ranged from 14 to 28. In addition to Cs-137 and Sr-90, the following radionuclides were detected in composite samples during this period: Sr-89, I-131, and Ba-140.

The maximum concentration of Sr-89 was detected in May 1963; the average value per sample was 158 pc/l corrected to midpoint of collection.

The Ba-140 concentrations were less than 10 pc/l during this period with the exception of November 1964, when two samples, corrected to midpoint of collection, showed 10 pc/l each.

All of the concentrations of I-131 in the composite-type milk samples were less than 10 pc/l with the exception of three samples in October 1964 and two in November which ranged from 20 pc/l to 70 pc/l at date of collection.

4.1.3 Air. The average gross beta concentration per sample in pc/m^3 detected in the four routine air samples++ each month is shown in Table 4.1. As can be noted, the activity levels in May 1963 were more than 7 pc/m^3 and gradually decreased to less than 1 pc/m^3 from July 1964 through March 1965, with the exception of October 1964 when the average gross beta per sample was 1.2 pc/m^3. These values are expressed in relation to the count date, i.e., usually four days after collection.

4.2 RESULTS, SALMON EVENT

4.2.1 Radiation Monitoring. No radioactivity above background was detected by ground monitors, aerial monitors, or background recorders.

Twenty-eight ground monitoring teams were employed in the field from H-60 minutes to H+95 minutes. All readings were background. A two-man aerial monitoring team flew patterns over Surface Zero and the surrounding off-site area from H+1 minute to H+49 minutes with negative results. The seven background recorders, Eberline Radiation Monitor, Model RM-11, that were placed in the field indicated no activity above background.

++ Collected from same stations as routine vegetation indicated in 4.1.1.

4.2.2 Film Badges. Six hundred and ninety-three film badges were distributed by the Public Health Service. These badges consisted of personal badges, station badges, and badges for on-site use. Dosimetry results showed no exposure for any of the badges.

4.2.3 Evacuation. Listed below are the number of individuals and families who were evacuated for this event:

Date	Individuals	Families
October 8 (postponed)	326	78
October 12 (postponed)	390	91
October 22 (D-day)	451	105

Nine individual persons were evacuated relative to medical activities.

4.2.4 Environmental Sampling. The results of the analyses of milk samples collected October 21 - November 6 in the off-site area are given in Table 4.2. These milk samples were samples collected from not more than two cows, in the majority of cases one cow, that graze in the woods around the test site, whereas the composite routine samples (Figure 4.1) are comprised of milk from a number of dairy farms that in the majority of cases have improved pastures for grazing.

The results of the analyses of air particulate samples are shown in Figures 4.2 and 4.3.

No radioactivity above background was found in water samples whereas data for vegetation samples showed a trend parallel to that for air and milk samples. Small concentrations of I-131 were detected in five vegetation samples that were collected within a 5-mile radius of the test site on November 5, 1964. The maximum concentration of I-131 in any one of the samples was 894 pc/kg, wet weight; the minimum concentration was 401 pc/kg, wet weight (activity corrected to date of collection). In comparison, the post-shot samples that were collected from the same area on October 22, 1964 (shot date) indicated all concentrations of I-131 less than 15 pc/kg.

An increase in radioactivity as a function of time in samples collected from the same location can be noted from the milk and air data (Table 4.2 and Figure 4.2 respectively). Of particular significance is the presence of I-131 in some of the milk samples collected after the day of the Salmon Event.

The graphs of the radioactivity in air particulate samples collected in the off-site area particularly demonstrate this rise in activity. In Figure 4.3, however, air radioactivity data from PHS Radiation Surveillance Network Stations (RSN) also show this rise in activity, with the exception of Atlanta, Georgia. This indicates that the radioactivity detected in the area of Project Dribble was most probably a part of the generalized atmospheric fall-out attributed to the Chinese nuclear weapon test of October 16, 1964.

4.3 RESULTS, POST-SHOT SAMPLING

Table 4.3 shows the various radionuclides detected in vegetation during the months of February and March with the average concentration per sample at time of count. The radionuclides detected in February were relative to the 4 routine samples (Figure 2.5 - A-27, 12, 52, 03) collected during that month prior to cavity penetration. The radionuclides detected in March were relative to 16 special vegetation samples, i.e., of the 21 vegetation sampling stations established prior to cavity penetration, 16 special samples were collected during this period of time.+++

Between March 10 and March 25 (March 10, 11, 23, 25), 33 special milk samples were collected from family-type milk cows within a 5-mile radius of Ground Zero. Each sample represented milk from not more than two cows and, as a general rule, one cow. The cows grazed in the woods around the test site area and only in a few exceptional cases was there any improved pasture for grazing. Also, the majority of the cows drank water from the creeks and streams in the area. The results of these sample analyses in terms of the average concentrations per sample at time of count are shown in Table 4.4 for Sr-90 and Cs-137.ɣ Background samples collected prior to cavity penetration showed similar values.

+++ "Project Dribble, Off-Site Radiological Surveillance," vegetation analyses, February and March 1965.

ɣ All I-131 values were less than 10 pc/l.

CHAPTER 5

CONCLUSIONS

Of the non-technical aspects, the most significant knowledge gained during the Salmon Event was that large numbers of people can be successfully evacuated, and a comprehensive off-site radiological safety program can be successfully conducted in a populated area if the confidence of the people toward the operation is maintained.

Considering the many occasions that the people were contacted relative to the surveys of the area and evacuation activities, extreme precautions were necessary to maintain the confidence of the people.

In developing evacuation procedures, it was learned that each family had to be considered on an individual basis, and that questions relative to the operation had to be answered truthfully and as precisely as possible. The people in the area expressed considerable concern relative to when the shot would be detonated and what the effects might be on them and their surroundings. They expressed major concern over possible damage to their water wells due to structural or radiological effects.

Although the people's attitudes toward the operation varied, attitudes were noticeably more favorable in the areas where Public Health Service representatives personally visited the residents and explained the objectives of the operation and how it might affect them.

The many data compiled concerning radioactivity in environmental samples between May 1963 and March 1965 are not only useful in describing the radiological situation in the Project Dribble area but also are significant for comparing this information with similar information throughout the country.

REFERENCES

1. "USPHS Off-Site Radiological Safety Program,Population Survey--Project Dribble, Mississippi, April 18 through August 5, 1963."

2. "USPHS Off-Site Radiological Safety Program, Milk Shed Survey--Project Dribble, Mississippi, April 18 through August 5, 1963."

3. "Processing and Distribution of Milk and Milk Products, Report of a Survey in the Vicinity of Project Dribble, May 1964."

4. "Project Dribble, Off-Site Radiological Surveillance," Monthly Reports since May 1963.

TABLE 2.1 AERIAL MONITORING DATA

Time	Location	Direction	Altitude	Readings
H+1 minute	Ground Zero	south to north	200 ft.	bkg
H+2 minutes	Ground Zero	north to south	treetop	bkg
H+7 minutes	Ground Zero	south to north	treetop	bkg
H+8 minutes	Ground Zero	north to south	treetop	bkg
H+15 minutes	Recorder Station (west of GZ)	south to north	treetop	bkg
H+20 minutes	Ground Zero	south to north	treetop	bkg
H+22 minutes	Ground Zero	north to south	treetop	bkg
H+26 minutes	Ground Zero	--	treetop	bkg
H+30 minutes	PHS house C-10 to PHS house C-14	north to south	treetop	bkg
H+40 minutes	5 mi. N of CP - CP	north to south	treetop	bkg
H+41 minutes	Ground Zero	--	treetop	bkg
H+46 minutes	Ground Zero	south to north	treetop	bkg
H+49 minutes	Ground Zero	west to east	treetop	bkg

Bkg, background. CP, Control Point.

TABLE 4.1 AIR DATA - ROUTINE SAMPLING

Month	Average Gross Beta Activity per Sample#, pc/m^3
May, 1963	7.3##
June	4.9
July	3.0
August	3.1
September	2.4
October	2.6
November	1.8
December	1.4
January, 1964	1.6
February	1.4
March	1.9
April	2.5
May	2.0
June	1.2
July	1.0
August	.3
September	.5
October	1.2
November	.5
December	.3
January, 1965	.3
February	.4
March	.4

#Activity at time of count, usually four days after collection.

##13 samples during this period indicated less than 5 pc/m^3.

TABLE 4.2 MILK SAMPLES (October 21 - November 6, 1964)

Location PHS House No.	Sample Number	Date of Collection	Activity I-131* pc/l	Activity Cs-137 pc/l	Activity K g/l
1	DM-(1)-1	10/26/64	<10	220	1.33
2	DM-(2)-1	10/26/64	<10	83	1.44
8	DM-(8)-1	10/26/64	<10	42	1.79
8	DM-(8)-2	11/5/64	49	67	1.64
12	DM-(12)-Bkg	10/21/64	<10‡	71	1.42
12	DM-(12)-1	10/27/64	35	54	1.32
13	DM-(13)-Bkg	10/23/64	<10‡	165	1.80
13	DM-(13)-1	10/27/64	20	193	1.66
13	DM-(13)-2	11/5/64	49	281	1.67
31	DM-(31)-1	10/26/64	<10	57	1.75
41	DM-(41)-Bkg	10/23/64	<10‡	118	1.28
41	DM-(41)-1	10/26/64	15	160	1.39
41	DM-(41)-2	11/6/64	47	202	1.20
A-82	DM-(A-82)-1	10/26/64	<10	82	1.45
B-2	DM-(B-2)-1	10/27/64	<10	52	1.75
B-23	DM-(B-23)-1	10/26/64	<10	180	1.87
B-23	DM-(B-23)-2	11/6/64	78	254	1.72
C-11	DM-(C-11)-1	10/26/64	<10	99	1.58
C-16	DM-(C-16)-Bkg	10/23/64	<10‡	66	1.03
C-16	DM-(C-16)-1	10/26/64	17	58	0.86
C-16	DM-(C-16)-2	11/5/64	54	74	1.01
C-21	DM-(C-21)-1	10/26/64	<10	71	1.40
D-19	DM-(D-19)-1	10/27/64	<10	104	1.36
D-20	DM-(D-20)-Bkg	10/23/64	<10‡	98	1.69
D-20	DM-(D-20)-1	10/27/64	19	126	1.62
D-20	DM-(D-20)-2	11/6/64	26	71	1.67
D-21	DM-(D-21)-Bkg	10/23/64	<10‡	74	1.63
D-21	DM-(D-21)-1	10/27/64	<10	78	1.58

*Corrected for decay to date of collection.

‡These samples were counted 11 to 13 days after collection. Therefore, the limit of detection for I-131 in reference to the date of collection will be approximately 30 pc/l.

TABLE 4.3 VEGETATION SAMPLE ANALYSES - February, March 1965

February (4 routine stations, collected 2/22/65)

	Ce-144	Ru-103, 106	Cs-137	Mn-54	Zr-Nb-95	K-40
Average Activity/** Sample pc/kg, Wet Weight	*	5,880	1,225	---	*	3,340
Range, pc/kg Wet Weight	1,010 - 2,390	380 - 12,200	140 - 2,360	---	960 - 1,140	270 - 6,640

March (16 special samples collected 3/21-3/22/65)

	Ce-144	Ru-103, 106	Cs-137	Mn-54	Zr-Nb-95	K-40
Average Activity/** Sample pc/kg, Wet Weight	12,471	9,654	5,228	1,952	*	*
Range, pc/kg Wet Weight	4,830 - 29,750	5,610 - 13,630	3,590 - 10,500	1,020 - 2,700	340 - 840	330 - 1,970

*This radioisotope not detected in all of the samples collected; therefore, only ranges are indicated.

**Activity at time of count.

TABLE 4.4 SPECIAL MILK SAMPLE ANALYSES (March 10 - March 25)

Post-Shot Activities

Date Collected	No. of Samples	Average Activity@ per sample, pc/l	
		Sr-90	Cs-137
3/10/65	8	74	98
3/11/65	4	57	126
3/23/65	10	95	114
3/25/65	11	88	119

@Activity at time of count.

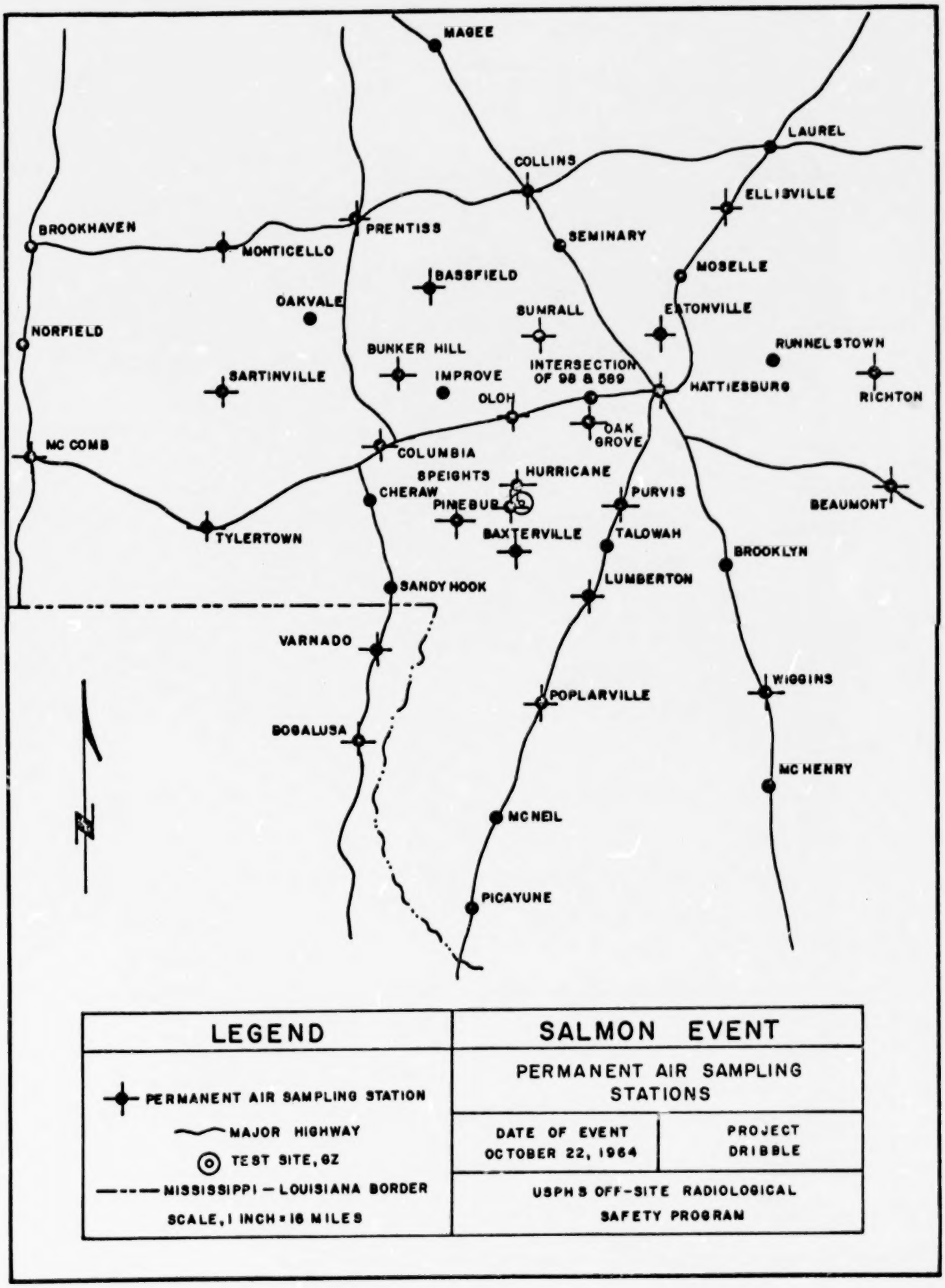
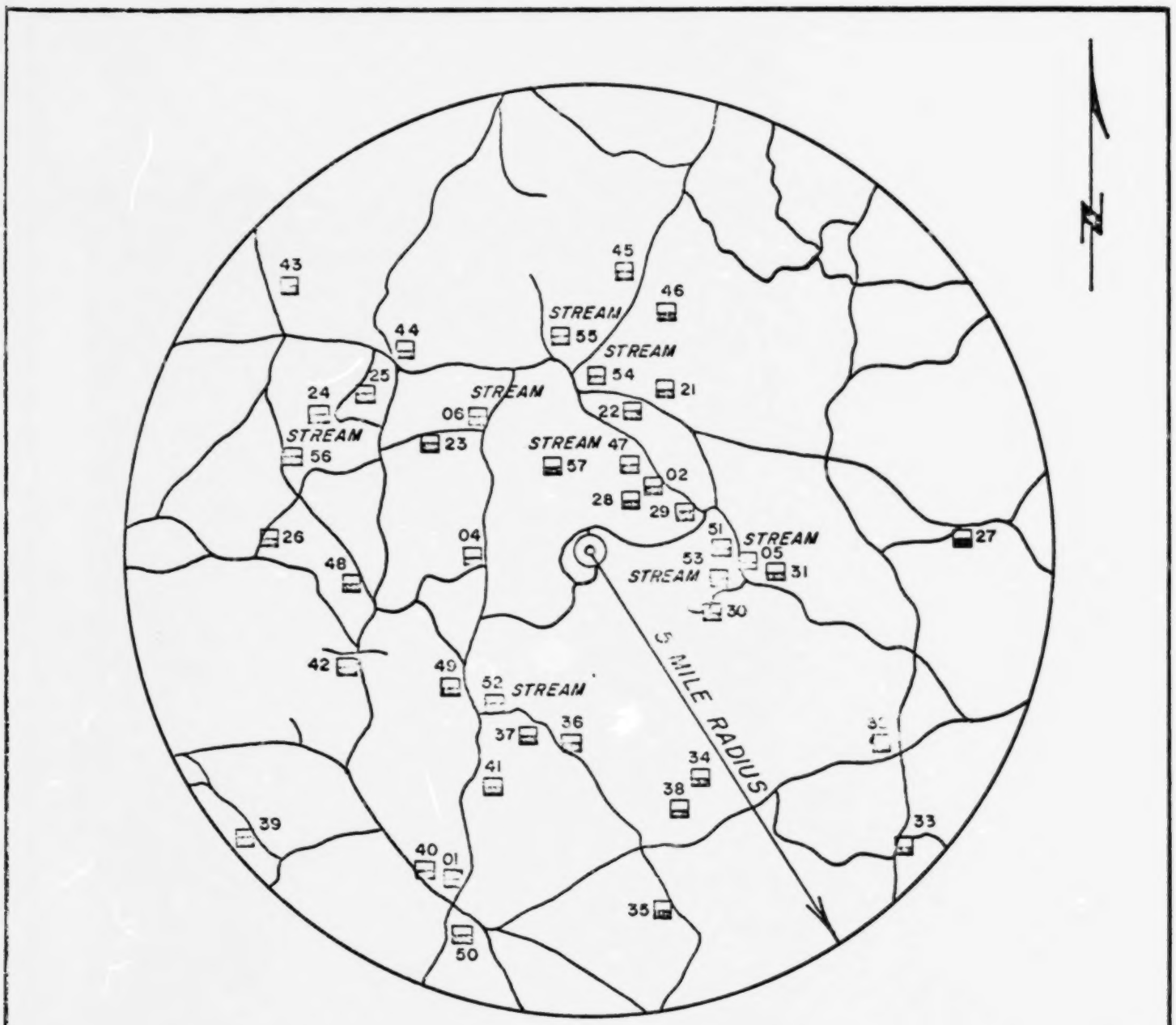


FIGURE 2.1 PERMANENT AIR SAMPLING STATIONS

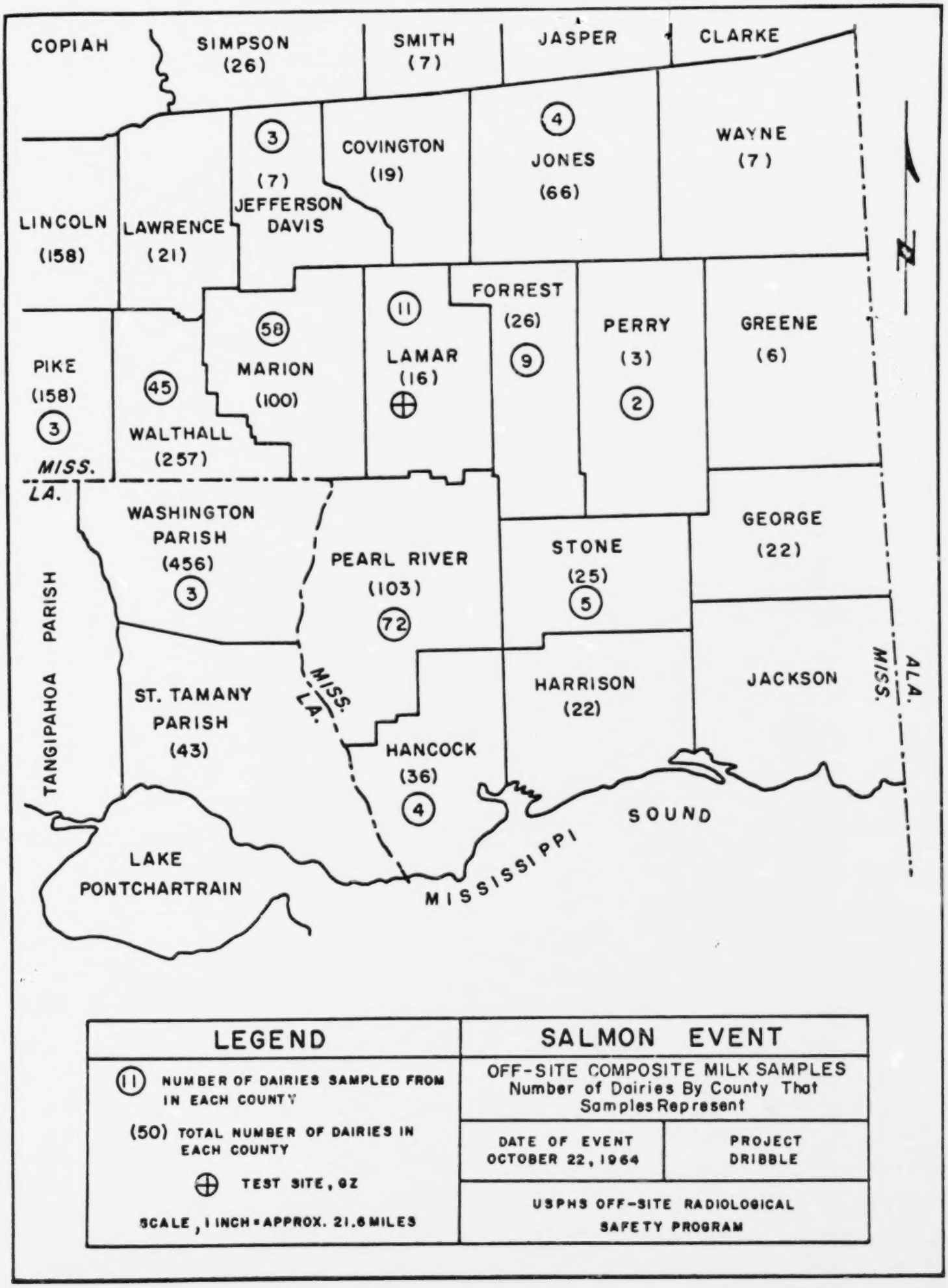


NOTE: ALL STATION CODE NUMBERS ARE PREFIXED BY THE LETTERS DW

NOTE: THE FOLLOWING SAMPLING STATIONS ARE NOT SHOWN: HATTIESBURG (N52°E,20MI.) DW-07, PURVIS (S83°E,10.5MI.) DW-03, POPLARVILLE (S5°E,21.5MI.) DW-10, COLUMBIA (N67°W,16MI.) DW-08, LUMBERTON (S36°E,12MI.) DW-09

LEGEND	SALMON EVENT	
01 WATER SAMPLING STATION	OFF-SITE WATER SAMPLING STATIONS	
MAJOR ROAD	DATE OF EVENT OCTOBER 22, 1964	PROJECT DRIBBLE
TEST SITE, GZ	USPHS OFF-SITE RADIOLOGICAL SAFETY PROGRAM	
SCALE, 1 INCH = 2 MILES		

FIGURE 2.2 OFF-SITE WATER SAMPLING STATIONS



LEGEND	SALMON EVENT
(11) NUMBER OF DAIRIES SAMPLED FROM IN EACH COUNTY	OFF-SITE COMPOSITE MILK SAMPLES Number of Dairies By County That Samples Represent
(50) TOTAL NUMBER OF DAIRIES IN EACH COUNTY	DATE OF EVENT OCTOBER 22, 1964 / PROJECT DRIBBLE
⊕ TEST SITE, GZ	USPHS OFF-SITE RADIOLOGICAL SAFETY PROGRAM
SCALE, 1 INCH = APPROX. 21.6 MILES	

FIGURE 2.3 OFF-SITE MILK SAMPLING COVERAGE, COMPOSITE SAMPLES

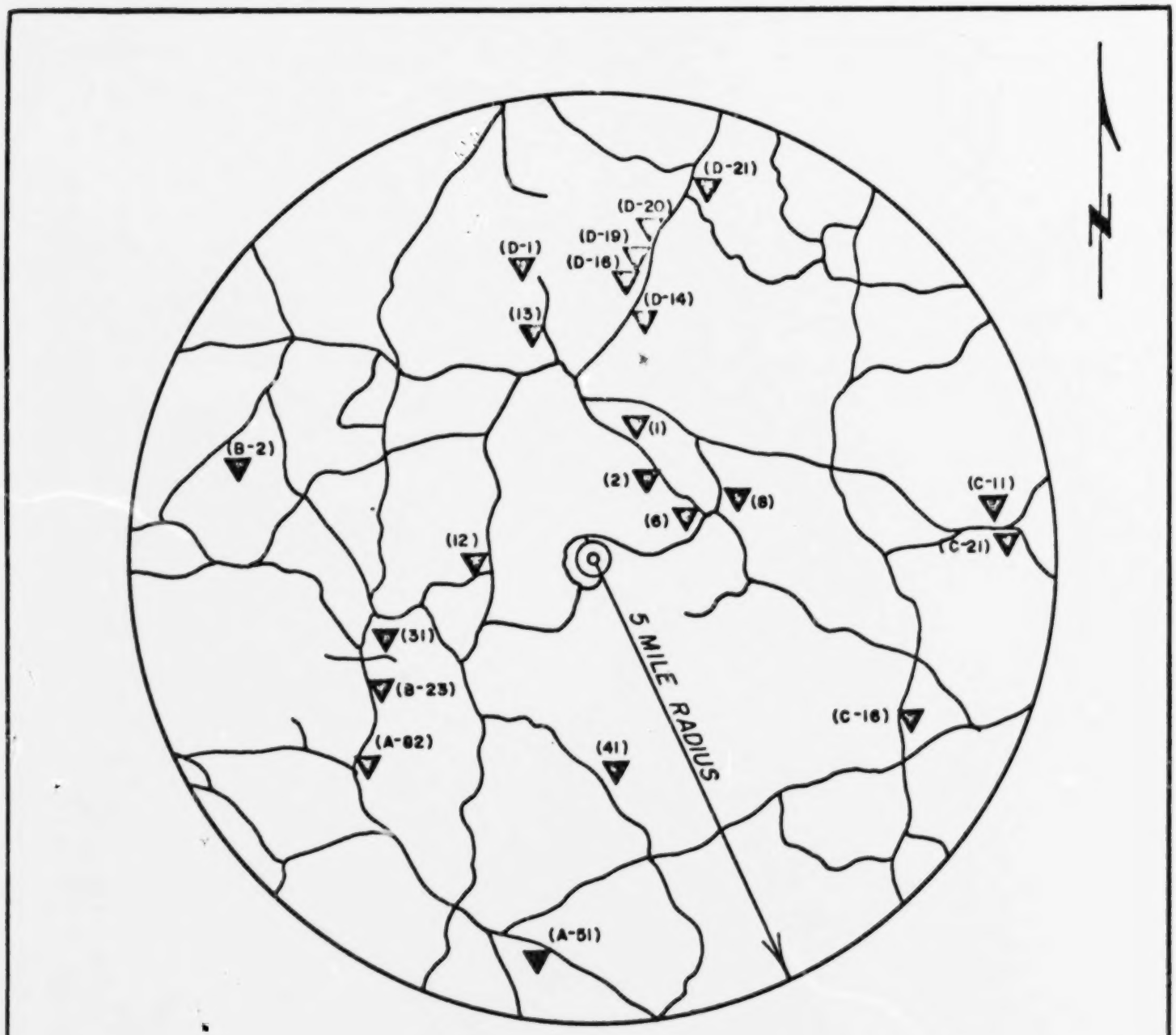


FIGURE 2.4 OFF-SITE MILK SAMPLING STATIONS WITHIN 5-MILE RADIUS

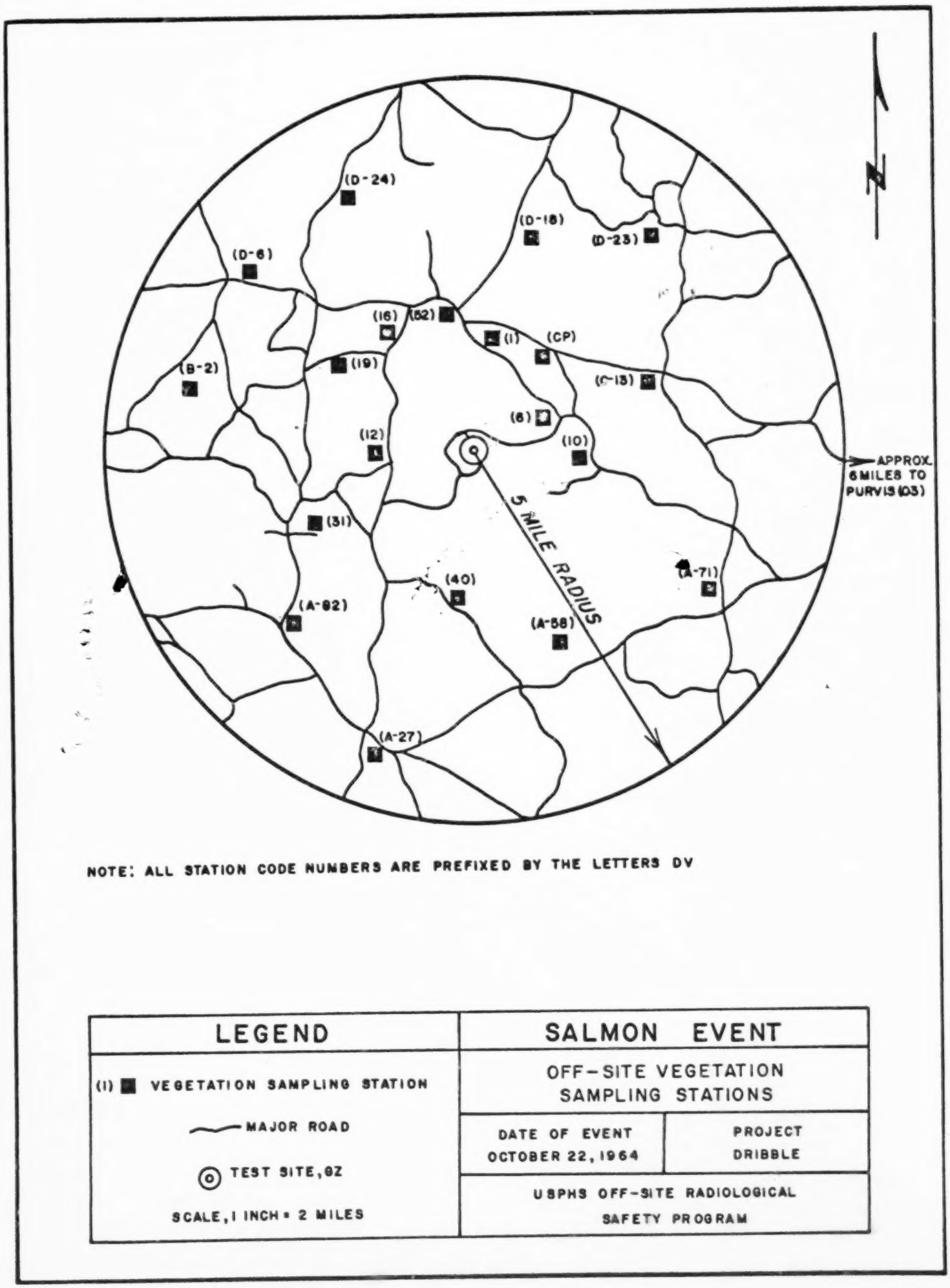


FIGURE 2.5 OFF-SITE VEGETATION SAMPLING STATIONS

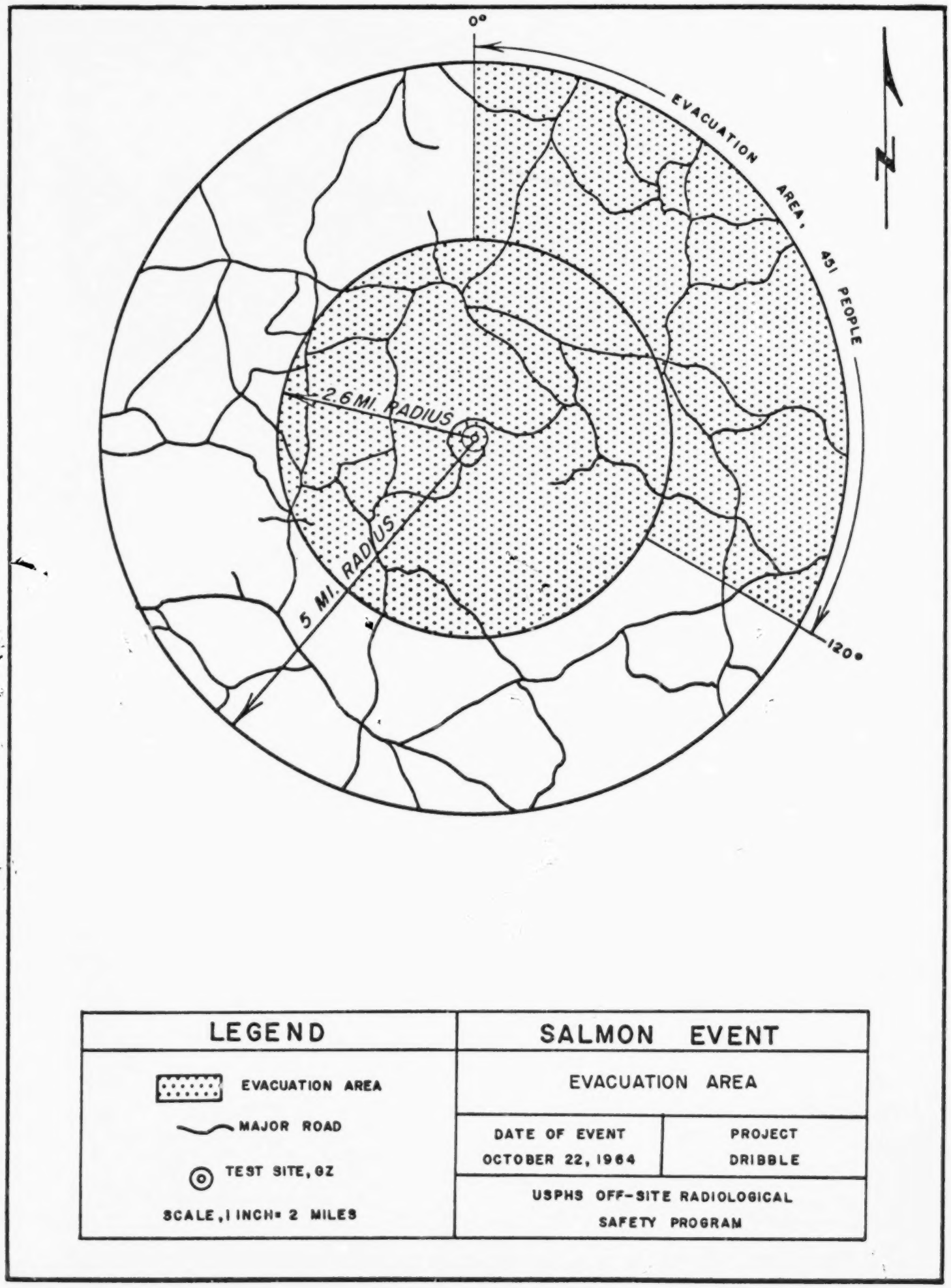


FIGURE 2.6 EVACUATION AREA

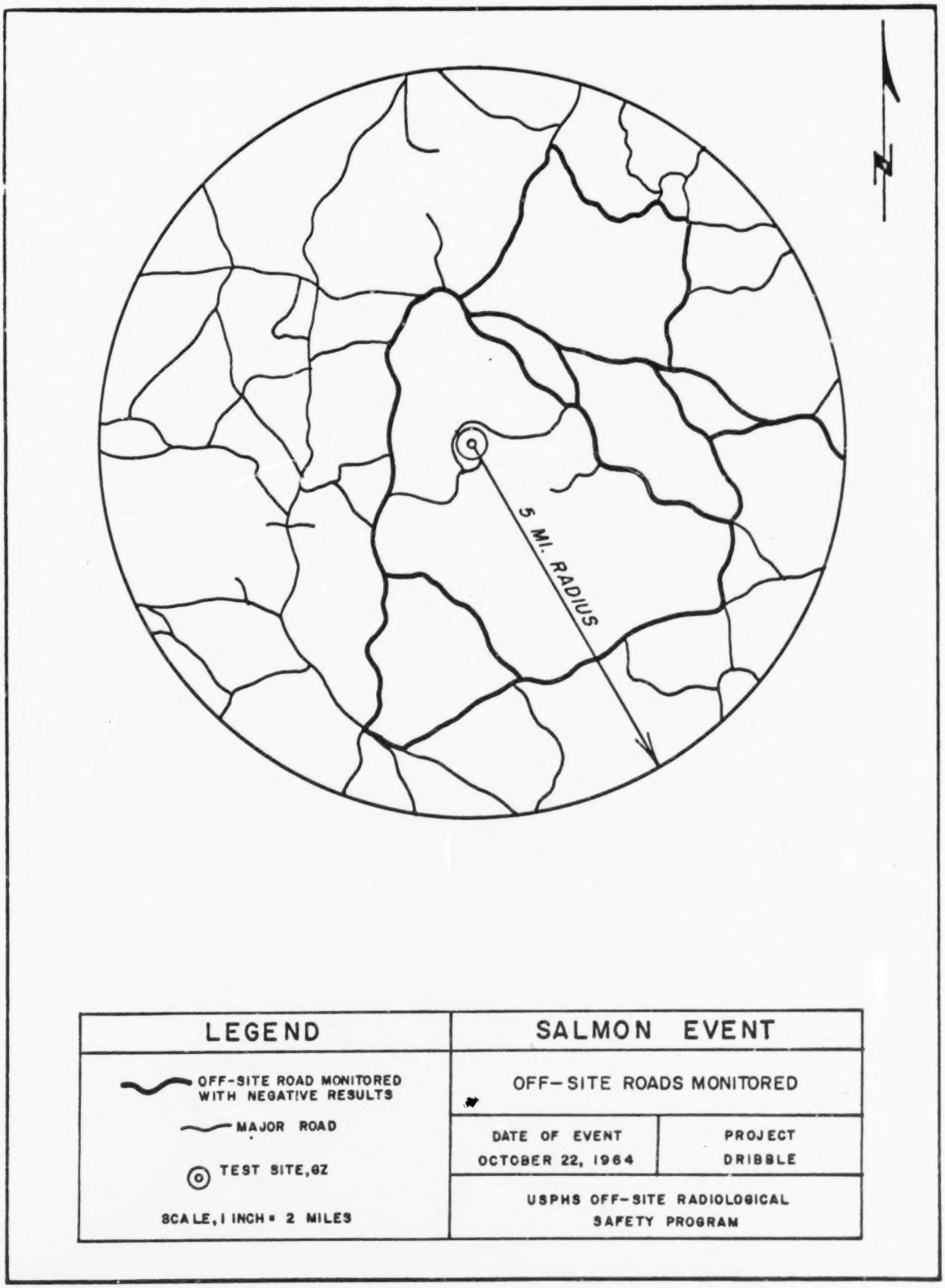


FIGURE 2.7 OFF-SITE ROADS MONITORED

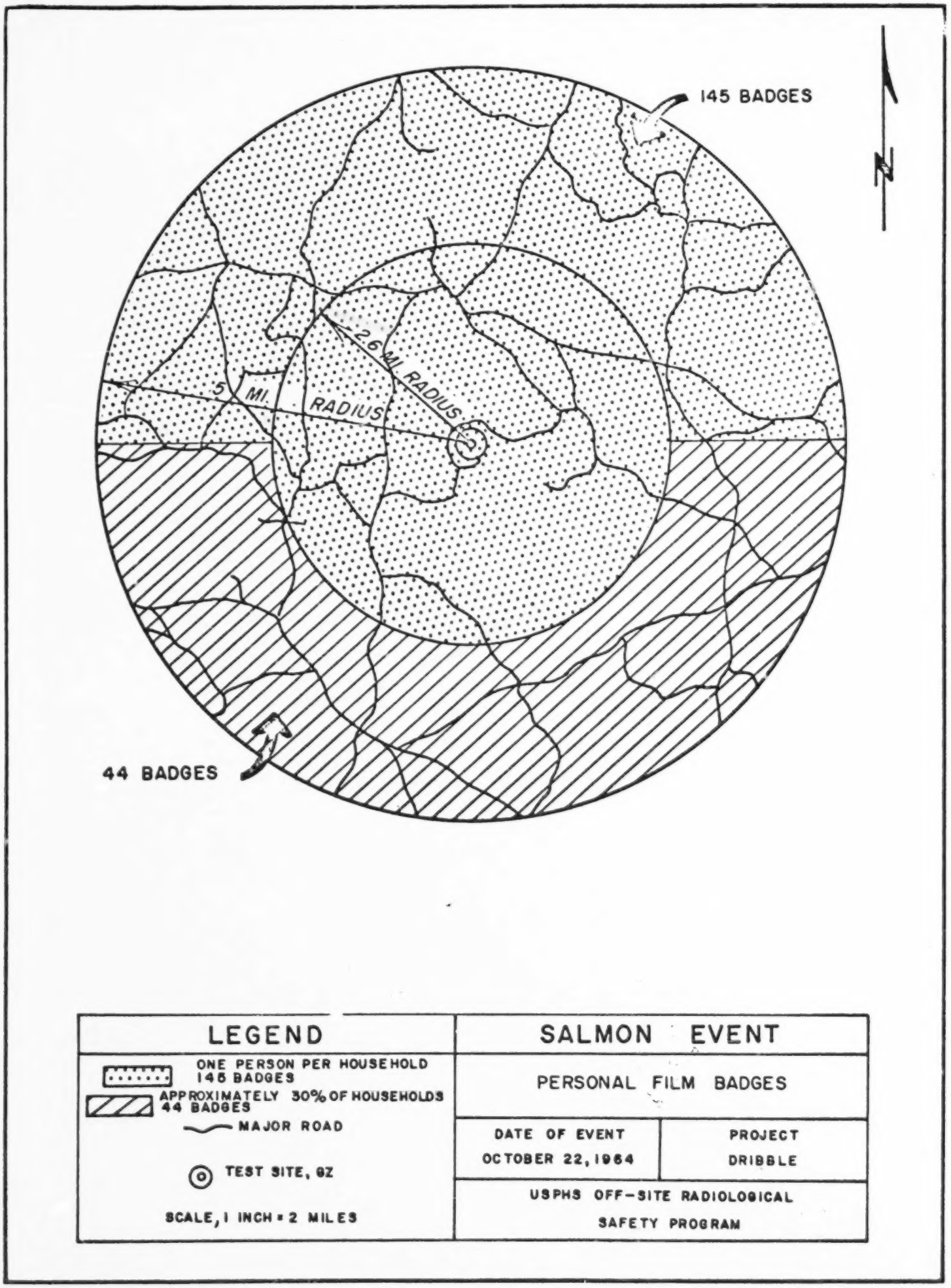


FIGURE 2.8 PERSONAL FILM BADGES

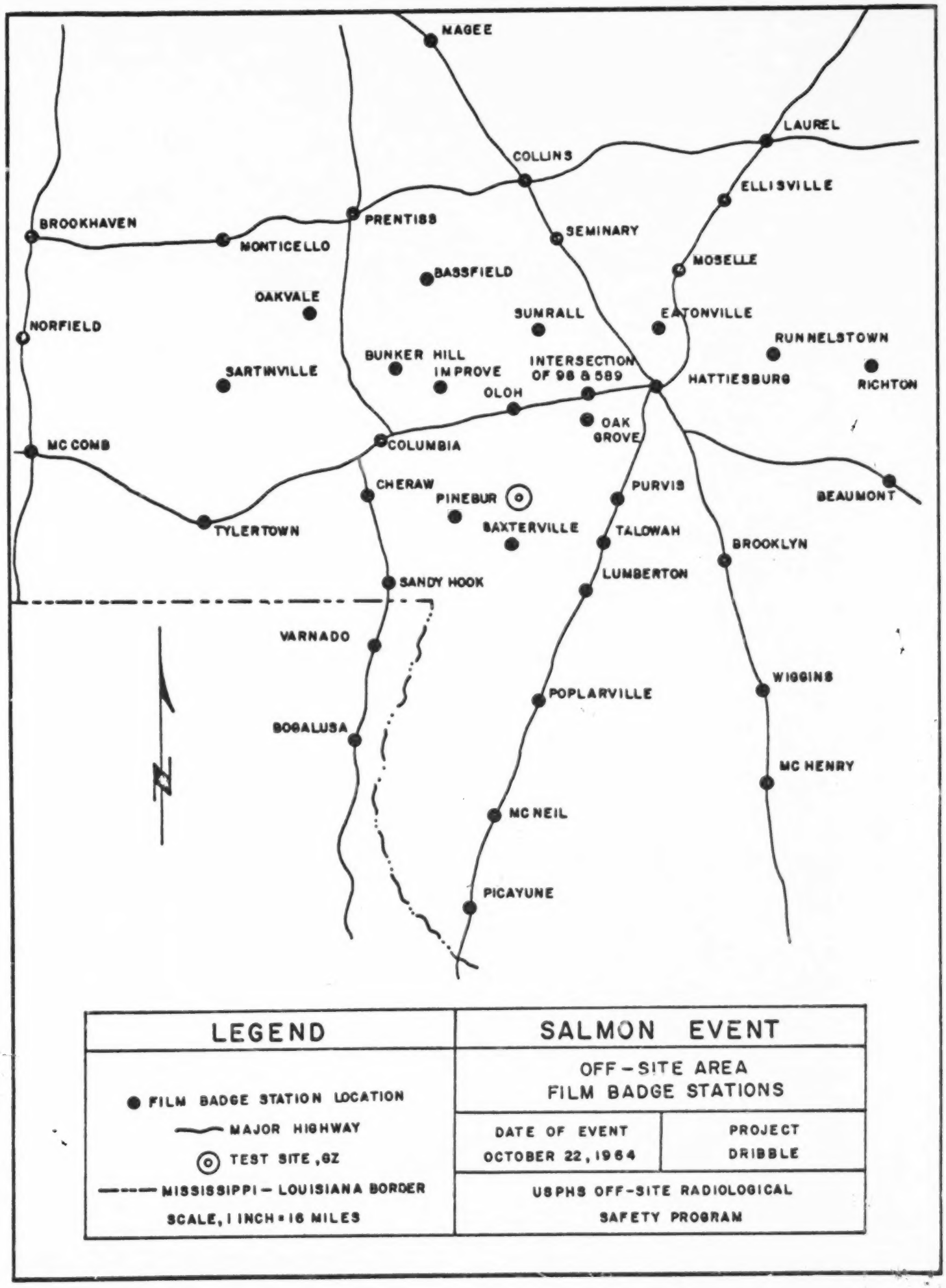


FIGURE 2.9 OFF-SITE AREA FILM BADGE STATIONS

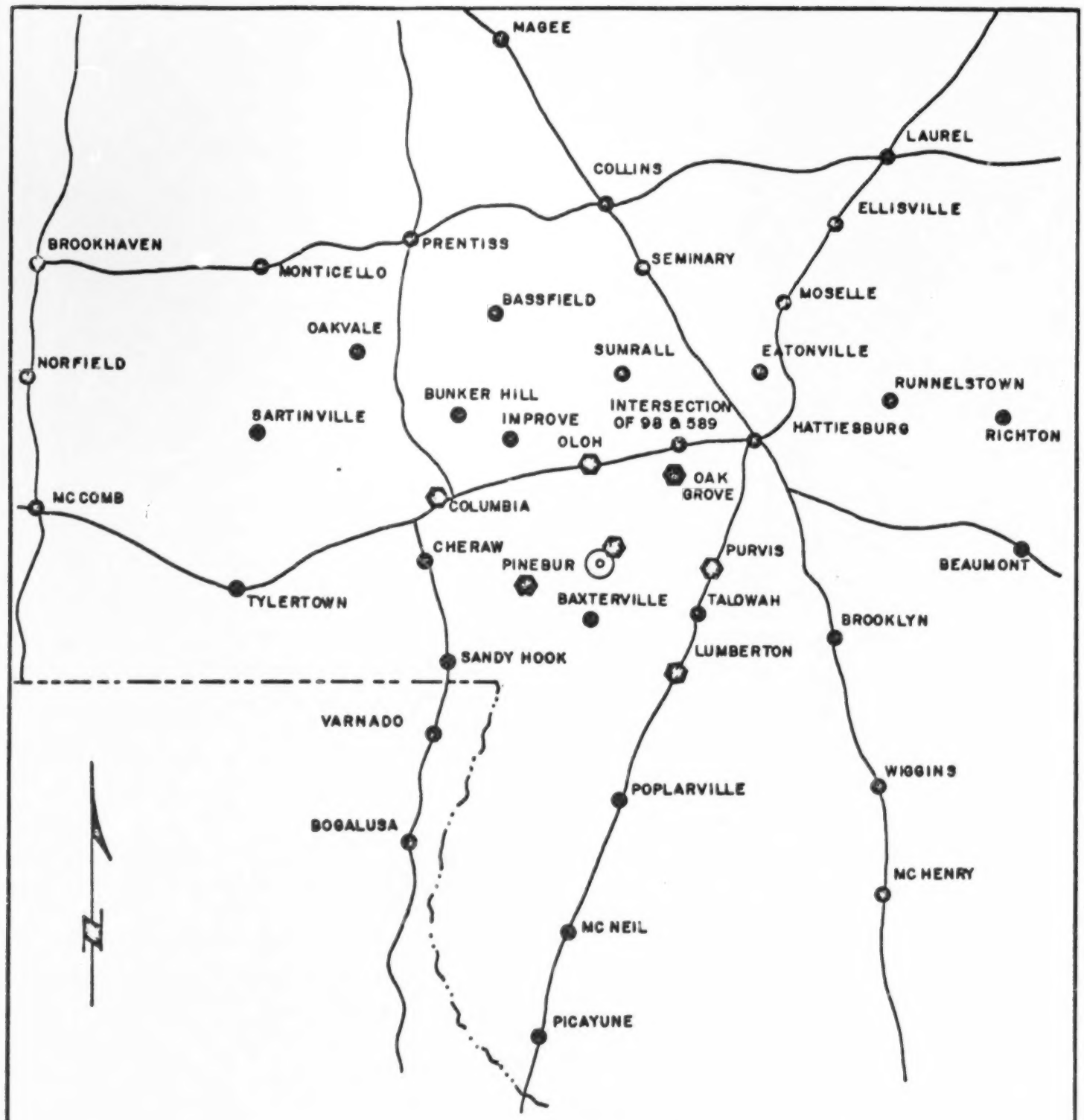


FIGURE 2.10 OFF-SITE BACKGROUND RECORDER STATIONS

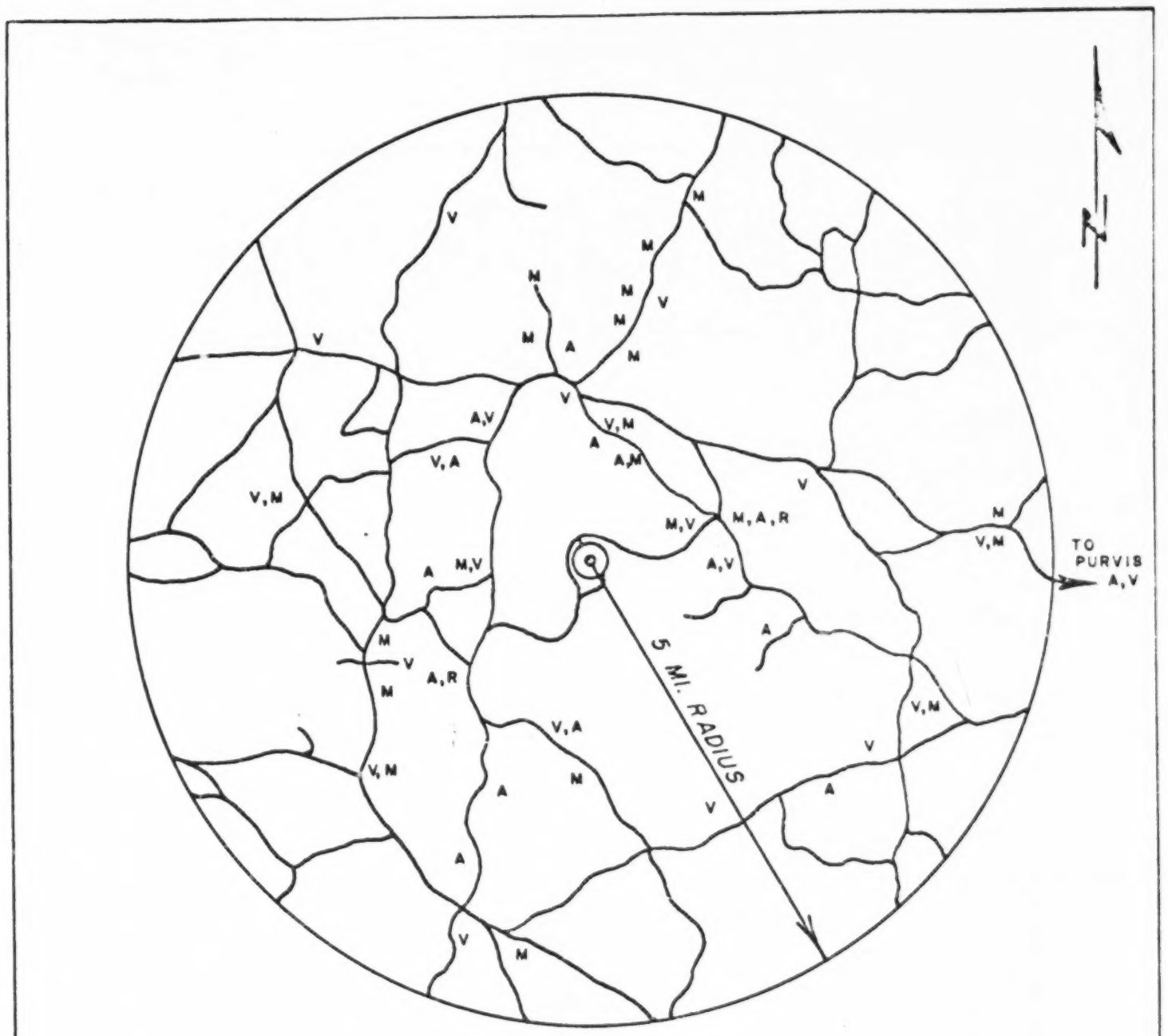


FIGURE 3.1 ENVIRONMENTAL SAMPLING WITHIN 5-MILE RADIUS – POST-SHOT ACTIVITIES

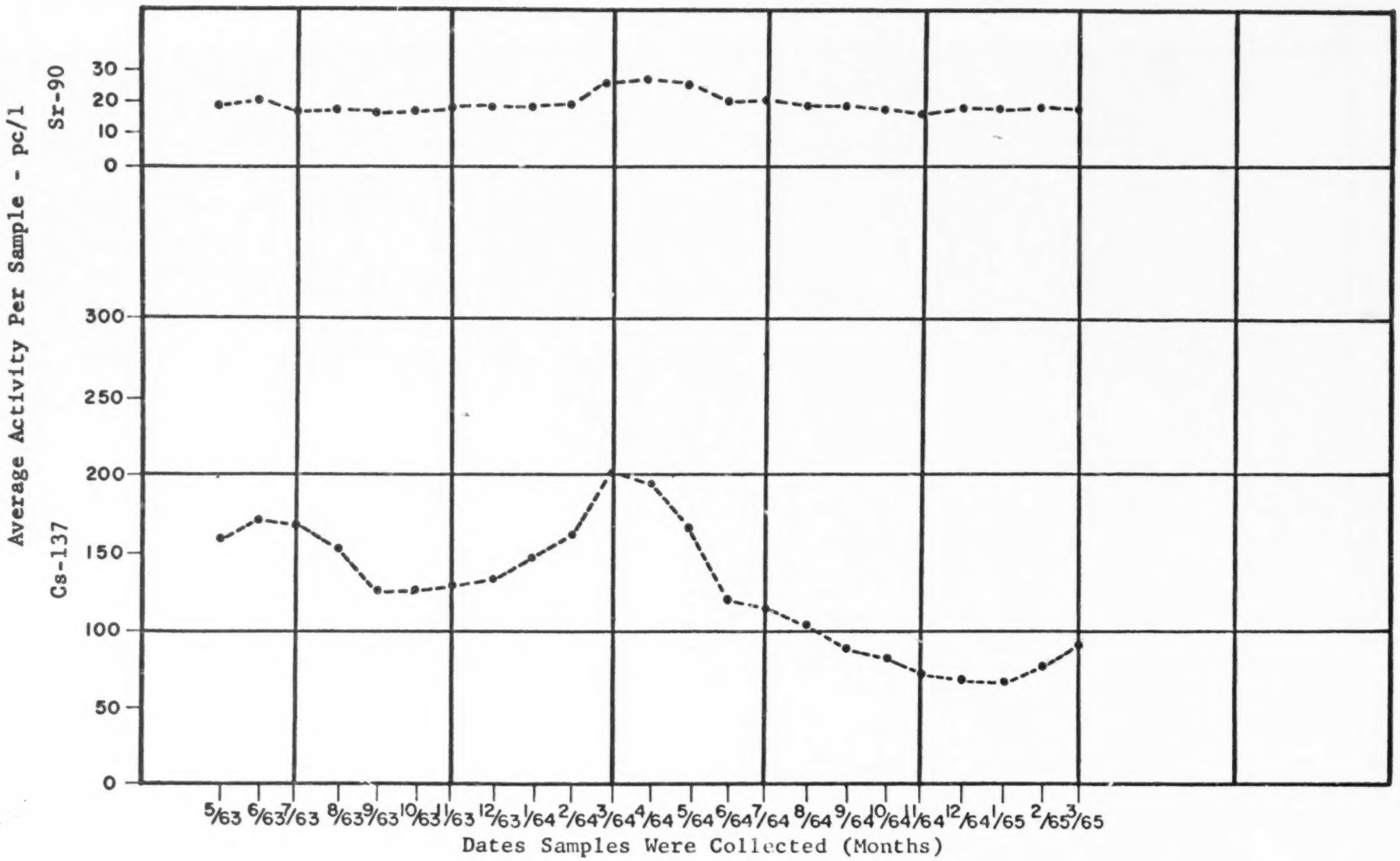


FIGURE 4.1 COMPOSITE MILK SAMPLE DATA (CS-137 – SR-90)

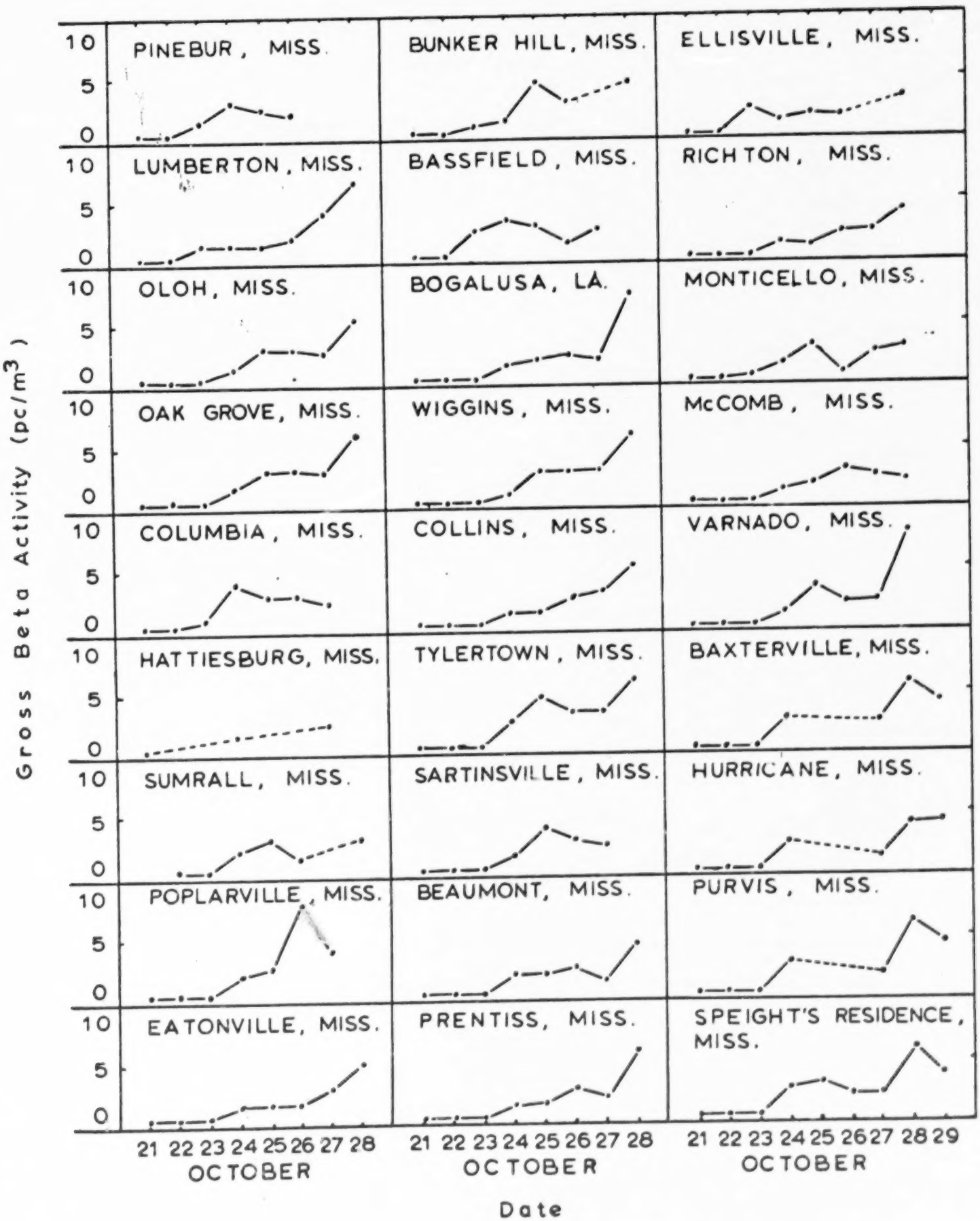


FIGURE 4.2 PROJECT DRIBBLE - AIR SAMPLING DATA

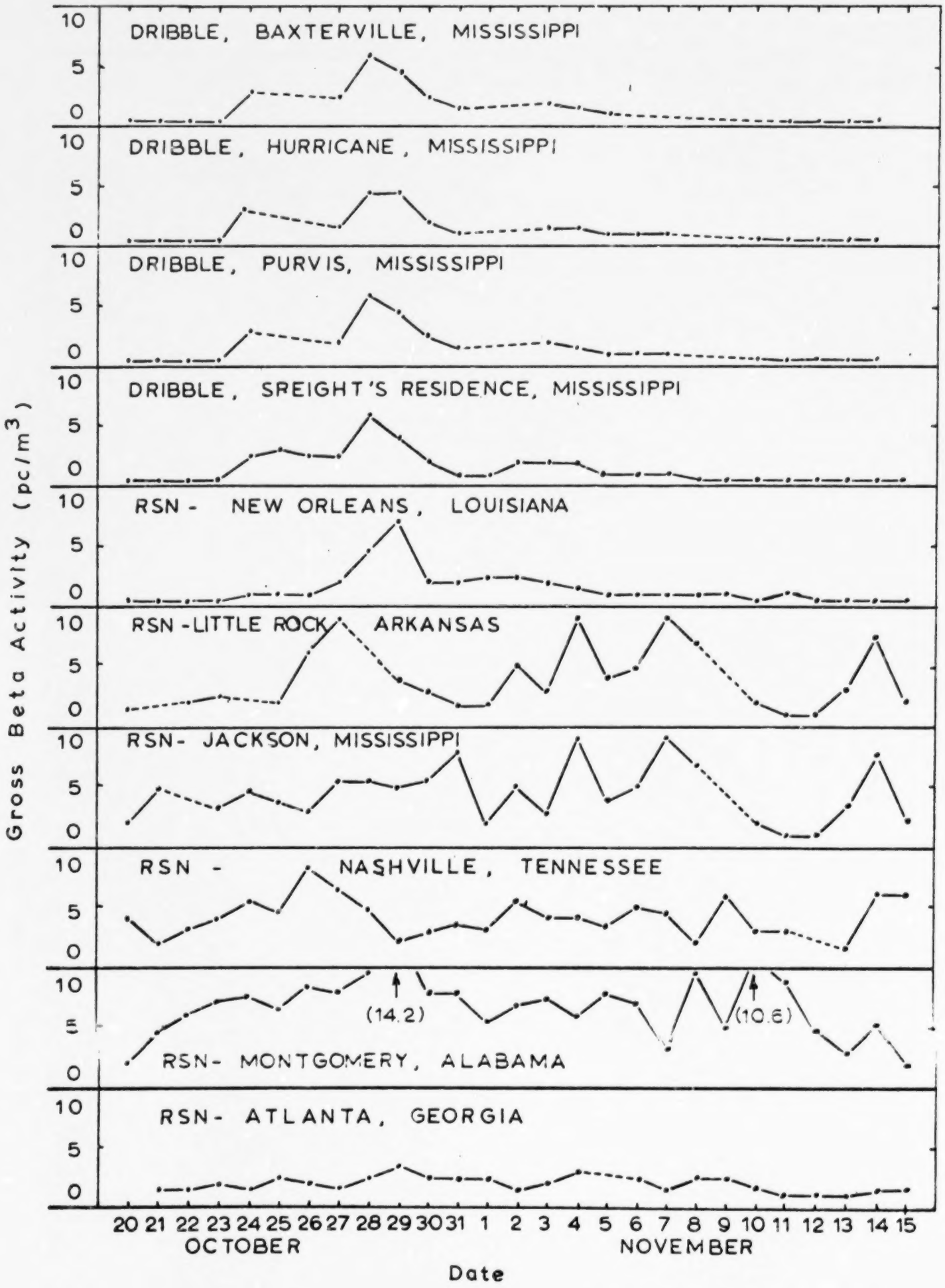


FIGURE 4.3 COMPARISION OF PROJECT DRIBBLE AND RSN AIR SAMPLING DATA

TECHNICAL AND SAFETY PROGRAM REPORTS SCHEDULED FOR ISSUANCE BY AGENCIES PARTICIPATING IN PROJECT DRIBBLE

SAFETY REPORTS

Agency	Report No.	Subject or Title
USWB	VUF-1020	Weather and Surface Radiation Prediction Activities
USPHS	VUF-1021	Final Report of Off-site Surveillance
USBM	VUF-1022	Pre and Post-Shot Safety Inspection of Oil and Gas Facilities Near Project Dribble
USGS	VUF-1023	Analysis of Geohydrology of Tatum Salt Dome
USGS	VUF-1024	Analysis of Aquifer Response
REECo	VUF-1025	On-Site Health and Safety Report
RFB, Inc.	VUF-1026	Analysis of Dribble Data on Ground Motion and Containment - Safety Program
H-NSC	VUF-1027	Ground-Water Safety
FAA	VUF-1028	Federal Aviation Agency Airspace Advisory
H&N	VUF-1029	Summary of Pre and Post-Shot Structural Survey Reports
JAB	VUF-1030	Structural Response of Residential-Type Test Structures in Close Proximity to an Underground Nuclear Detonation
JAB	VUF-1031	Structural Response of Tall Industrial and Residential Structures to an Underground Nuclear Detonation.

NOTE: The Seismic Safety data will be included in the USC&GS Technical Report VUF-3014

TECHNICAL REPORTS

Agency	Report No.	Subject or Title
SL	VUF-3012	Free-Field Particle Motions from a Nuclear Explosion in Salt - Part I
SRI	VUF-3013	Free-Field Particle Motions from a Nuclear Explosion in Salt - Part II
USC&GS	VUF-3014	Earth Vibration from a Nuclear Explosion in a Salt Dome
UED	VUF-3015	Compressional Velocity and Distance Measurements in a Salt Dome

LRL	VUF-3016	Design and Operation of a Chemical Processing Plant for Controlled Release of a Radioactive Gas from the Cavity of a Nuclear Explosion in Salt
LRL	PNE-3002 *	Response of Test Structures to Ground Motion from an Underground Nuclear Explosion
SRI	VUF-3017	Feasibility of Cavity Pressure and Temperature Measurements for a Decoupled Nuclear Explosion
LRL	VUF-3018	Background Engineering Data and Summary of Instrumentation for a Nuclear Test in Salt
WES	VUF-3019	Laboratory Design and Analyses and Field Control of Grouting Mixtures Employed at a Nuclear Test in Salt
LRL	VUF-3020	Geology and Physical and Chemical Properties of the Site for a Nuclear Explosion in Salt
EG&G	VUF-3021	Timing and Firing

* This report number was assigned by SAN

In addition to the reports listed above as scheduled for issuance by the Project DRIBBIE test organization, a number of papers covering interpretation of the SAIMON data are to be submitted to the American Geophysical Union for publication. As of February 1, 1965, the list of these papers consists of the following:

Title	Author(s)	Agency(s)
Shock Wave Calculations of Salmon	L. A. Rogers	LRL
Nuclear Decoupling, Full and Partial	D. W. Patterson	LRL
Calculation of P-Wave Amplitudes for Salmon	D. L. Springer and W. D. Hurdlow	LRL
Travel Times and Amplitudes of Salmon Explosion	J. N. Jordan W. V. Mickey W. Helterbran	USC&GS AFTAC UED
Detection, Analysis and Interpretation of Teleseismic Signals from the Salmon Event	A. Archambeau and E. A. Flinn	SDC
Epicenter Locations of Salmon Event	E. Herrin and J. Taggart	SMU USC&GS
The Post-Explosion Environment Resulting from the Salmon Event	D. E. Rawson and S. M. Hansen	LRL
Measurements of the Crustal Structure in Mississippi	D. H. Warren J. H. Healy W. H. Jackson	USGS

All but the last paper in the above list will be read at the annual meeting of the American Geophysical Union in April 1965.

LIST OF ABBREVIATIONS FOR TECHNICAL AGENCIES

BR LTD	Barringer Research Limited Rexdale, Ontario, Canada
ERDL	Engineering Research Development Laboratory Fort Belvoir, Virginia
FAA	Federal Aviation Agency Los Angeles, California
GIMRADA	U. S. Army Geodesy, Intelligence and Mapping Research and Development Agency Fort Belvior, Virginia
H-NSC	Hazleton-Nuclear Science Corporation Palo Alto, California
H&N, INC	Holmes & Narver, Inc. Los Angeles, California Las Vegas, Nevada
II	Isotopes, Inc. Westwood, New Jersey
ITEK	Itek Corporation Palo Alto, California
JAB	John A. Blume & Associates Research Division San Francisco, California
LRL	Lawrence Radiation Laboratory Livermore, California
NRDL	U. S. Naval Radiological Defense Laboratory San Francisco, California
REECo	Reynolds Electrical & Engineering Co., Inc. Las Vegas, Nevada
RFB, INC.	R. F. Beers, Inc. Alexandria, Virginia
SDC	Seismic Data Center Alexandria, Virginia
EG&G	Edgerton, Germeshausen & Grier, Inc. Las Vegas, Nevada
SL	Sandia Laboratory Albuquerque, New Mexico
SMU	Southern Methodist University Dallas, Texas
SRI	Stanford Research Institute Menlo Park, California
TI	Texas Instruments, Inc. Dallas, Texas
UA	United Aircraft El Segundo, California
UED	United Electro Dynamics, Inc. Pasadena, California
USBM	U. S. Bureau of Mines Washington, 25, D. C.
USC&GS	U. S. Coast and Geodetic Survey Las Vegas, Nevada
USGS	U. S. Geologic Survey Denver, Colorado
USPHS	U. S. Public Health Service Las Vegas, Nevada
USWB	U. S. Weather Bureau Las Vegas, Nevada